LOWER ARKANSAS RIVER BASIN CATEGORY 4B ALTERNATIVE

Water Body / Assessment Unit: Little Arkansas River
Water Quality Impairment: Atrazine

1. INTRODUCTION

Subbasin: Little Arkansas

Counties: Ellsworth, Rice, McPherson, Reno, Harvey, Marion, and Sedgwick

HUC 8: 11030012

Ecoregion: Central Great Plains, Smoky Hills (27a)
Central Great Plains, Great Bend Sand Prairie (27c)
Central Great Plains, Wellington-McPherson Lowland (27d)

Drainage Area: Approximately 1404 square miles

Primary Segments with tributaries covered under 4B Alternative by HUC 8 and Watershed/Station Number:
HUC 8 11030012
Watershed: Little Arkansas River

Station	***Main Segment***	***Trib 1***	***Trib2***
Station 533	**Turkey Creek (11)**	Dry Turkey Cr (13)	Bull Cr (24)
	Turkey Creek (12)	Running Turkey Cr (25)	
Station 246	**Little Arkansas River (10-part)**		
	Little Arkansas River (14)	Sand Cr (23)	
		Lone Tree Cr (20)	
		Dry Cr (22)	
		Salt Cr (21)	
		Horse Cr (19)	
Station 705	**Black Kettle Cr (368)**		
Station 703	**Kisiwa Cr (15)**		
Station 534	**Emma Cr (6)**	Middle Emma Cr (7)	
		West Emma Cr (8)	
Station 535	**Sand Cr (4)**	Mud Cr (16)	
		Beaver Cr (26)	

Station 282	**Little Arkansas R (1-part)**	Jester Cr (2)	Gooseberry Cr (17)
			W. Fk. Jester Cr (18)
	Little Arkansas R (3)		
	Little Arkansas R (5)		
	Little Arkansas R (9)		
	Little Arkansas R (10-part)		
Station 728	**Little Arkansas R (1-part)**	Middle Fk Chisholm Cr (817)	
		Chisholm Cr (1693)	

Downstream Segments Influenced by implementation of 4B Alternative

Station 729	**Arkansas R (3 – part)**	Chisholm Cr (4)	Gypsum Cr (5)
		Chisholm Cr (6)	E. Chisholm Cr (7)
		Chisholm Cr (8)	

Station 281 **Arkansas R (3 – part)**

Designated Uses for Main Stem Segments:

Little Arkansas River (10, 14, 1, 3, 5, & 9): Primary B contact Recreation for segment 1 & 14; Primary contact C Recreation for segments 10, 3, 9, & 5; Expected Aquatic Life Support, Domestic Water Supply; Food Procurement; Groundwater Recharge; Industrial Water Supply; Irrigation; Livestock Watering.

Turkey Creek (11 & 12): Primary C contact Recreation for segment 11; Expected Aquatic Life Support; Food Procurement for segment 12.

Black Kettle Cr (368): Primary B contact Recreation; Expected Aquatic Life Support.

Kisiwa Cr (15): Expected Aquatic Life Support.

Emma Cr (6): Expected Aquatic Life Support; Food Procurement.

Sand Cr (4): Primary B contact Recreation; Expected Aquatic Life Support; Food Procurement.

Arkansas River (3): Primary B Contact Recreation, Special Aquatic Life Use Water; Domestic Water Supply; Food Procurement; Groundwater Recharge; Industrial Water Supply; Irrigation; Livestock Watering.

2004 303 (d) Listing: Lower Arkansas Basin Streams: Little Arkansas River Segments listed for atrazine: Station 246- Upper Little Arkansas R segments 10-part & 14; Station 534-Emma Creek segment 12; Station 535-Sand Creek

segment 4; Station 282-Middle Little Arkansas R. segments 1-part, 3, 5, 9, & 10-part. In addition the downstream segments within the Middle Arkansas-Slate Subbasin that will be directly affected by the 4B alternative carry forward to atrazine listings associated with Station 729 and Station 281 along the Arkansas River, segment 3.

Impaired Use: All Waters within the Little Arkansas subbasin are General Purpose Waters with Expected Aquatic Life Support. All segments along the Little Arkansas River are designated for Domestic Water Supply.

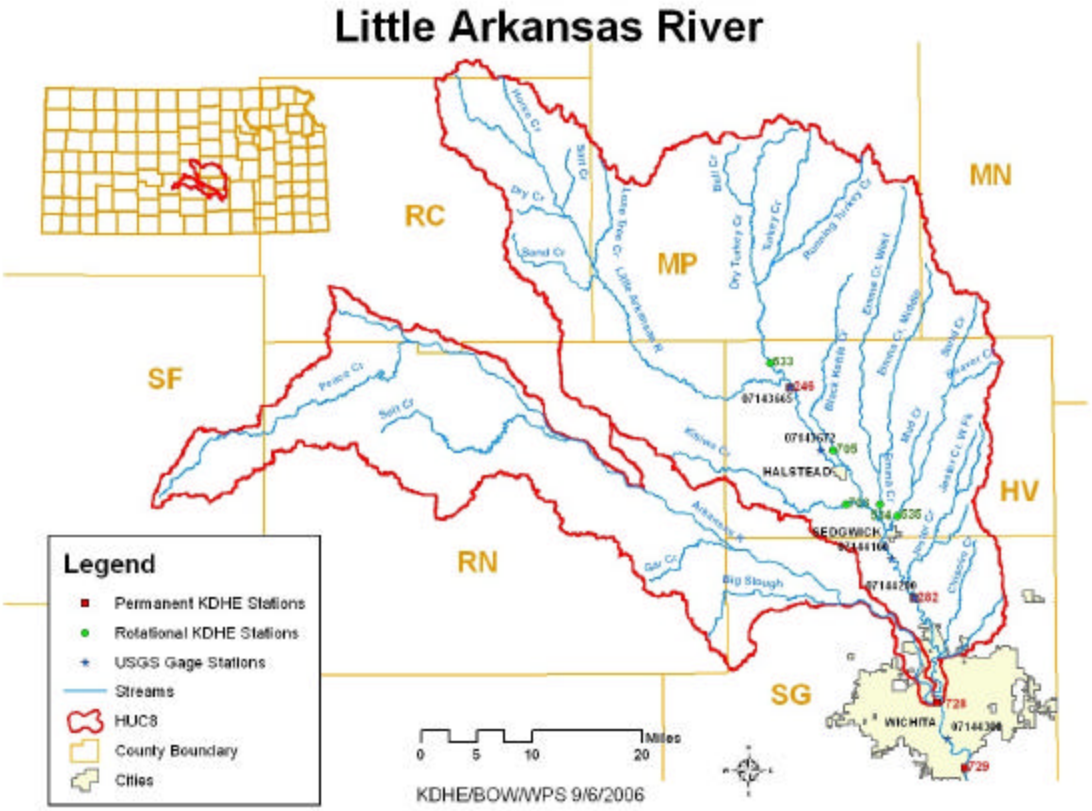
Water Quality Criteria: Domestic Water Supply – Atrazine: 3 µg/l (ppb)
Aquatic Life Support – Atrazine Chronic: 3 µg/l (ppb)
Aquatic Life Support – Atrazine Acute: 170 µg/l (ppb)

Watershed Description: The Little Arkansas River watershed is located within the eastern portion of Rice, McPherson, northeastern Reno, southwestern Marion, Harvey, and north central Sedgwick counties. The river drains into the Arkansas River in Wichita after traveling approximately 80 miles from the headwaters near Geneseo in Rice County. There are 478 stream miles in the watershed that encompasses approximately 1,404 square miles. Within the watershed, there are numerous public water supply wells and several distribution plants that obtain water from the Little Arkansas River and from the groundwater within its alluvium.

The aquifers within the watershed, which includes the High Plains aquifer, the Dakota aquifer, the Little Arkansas River alluvial aquifer, and the Equus Beds, are being utilized by approximately 7,400 groundwater wells for domestic use or irrigation with numerous monitoring wells in place for water level measurements and/or water quality sampling. During high flow events the water from the Little Arkansas River is being utilized for artificial groundwater recharge, storage and recovery in order to provide supplemental drinking water for the city Wichita. All waters reintroduced to the aquifer during groundwater recharge must be free of pollutants, and therefore water-containing concentrations of atrazine must be filtrated through charcoal filers to remove the pollutant. This process is considerably costly for the City of Wichita. (Little Arkansas River Watershed Website, http://www.oznet.ksu.edu/littlearkansas)

Landuse within the Little Arkansas watershed is as follows: 78% of cropland, 19% grazing land or grassland, 2% urban, and 1% is woodlands. The major cropland portion of the watershed primarily comprises corn, soybeans, wheat and sorghum.

Figure 1. Little Arkansas River Watershed Base Map.



2. PROBLEM STATEMENT AND DESCRIPTION

Period of Record Used:

Water Quality Data (Sources):

Turkey Creek: 1990-2006 (KDHE Station 533)
Little Arkansas R @ Alta Mills: 1986-2006 (KDHE Station 246)
Little Arkansas R Hwy 50 nr Halstead: 1995-2004 (USGS Station 07143672)
Black Kettle Cr: 1995-2003 (KDHE Station 705)
Kisiwa Cr: 1994-2002 (KDHE Station 703)
Emma Cr: 1990-2006 (KDHE Station 534)
Sand Cr: 1990-2006 (KDHE Station 535)
Little Arkansas R nr Sedgwick: 1995-2004 (USGS Station 07144100)
Little Arkansas R @ Valley Center: 1985-2006 (KDHE Station 282)
Little Arkansas R above confluence w/ Ark R: 2000-2006 (KDHE Station 728)
Arkansas R below confluence with Little Ark R: 2000-2006 (KDHE Station 729)
Arkansas R @ Derby: 1986-2006 (KDHE Station 281)
Arkansas R @ Maize: 1990-2006 (KDHE Station 536)

Streamflow:
Little Arkansas R @ Alta Mills: 1995-2006 (USGS Station 07143665)
Little Arkansas R Hwy 50 nr Halstead: 1995-2006 (USGS Station 07143672)
Little Arkansas R nr Sedgwick: 1995-2006 (USGS Station 07144100)
Little Arkansas R @ Valley Center: 1995-2006 (USGS Station 07144200)
Arkansas R @ Wichita: 1995-2006 (USGS Station 07144300)
Arkansas R @ Derby: 1995-2006 (USGS Station 07144550)

Table 1. Selected Flow Statistics for USGS Stations in the Little Arkansas River Basin. Drainage Area (D.A.) in square miles; flow percentiles in cubic feet per second (cfs).

USGS Station #	Station Location	Drainage Area (Sq. Miles)	90% cfs	75% cfs	50% cfs	25% cfs	10% cfs
07143665	Lit Ark R, Alta Mills	720	5.1	9.4	20	57	300
07143672	Lit Ark R, Hwy 50 nr Halstead	759	11	16	26	78	401
07144100	Lit Ark R, nr Sedgwick	1265	22	35	58	136	603
07144200	Lit Ark R, at Valley Center	1345	22	38	68	162	695
07144300	Ark River @ Wichita	37914	125	201	396	832	2240
07144550	Ark River @ Derby	38000	187	298	533	1090	2560

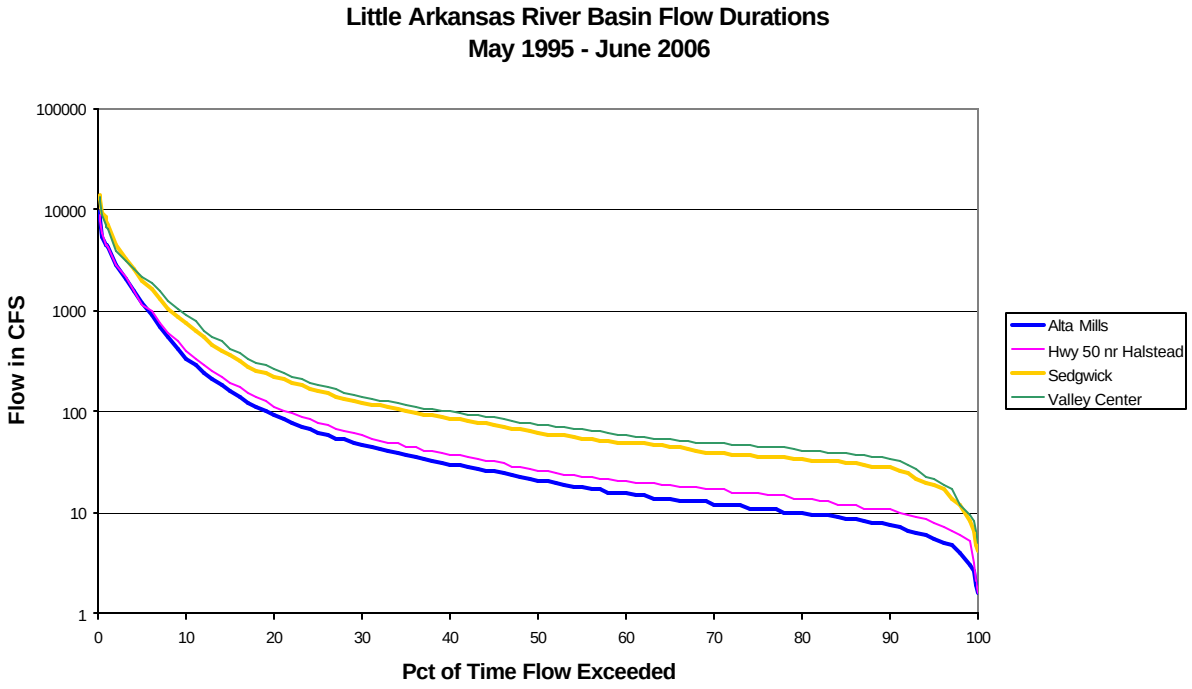
The Little Arkansas River Basin has several segments listed on the 2004-303(d) list for atrazine water quality impairments. The segments not listed on the 303(d) list within the watershed all have samples that have exceeded the water quality criteria for Drinking Water Supply and Chronic Aquatic Life, with the exception of Station 705 on Black Kettle Creek. However, the sampling stations associated with the segments that are not listed are primarily rotational sampling stations, and therefore lack the sufficient number of samples over the water quality criteria to actually list these segments under Category 5 on the prior 303(d) lists. Since agricultural land uses throughout the watershed are subject to atrazine application practices, this Category 4B alternative will be applicable to the entire watershed of the Little Arkansas River and will benefit the downstream reach of the Arkansas River from Wichita to Derby.

Table 2. Selected Flow Statistics for segments with KDHE stream chemistry monitoring stations in the Little Arkansas Basin. Flow durations from USGS Scientific Investigations Report 2005-5033.

Station	Stream	Drainage Area (Sq. Miles)	90% cfs	75% cfs	50% cfs	25% cfs	10% cfs
SC533	Turkey Creek	279	0	.48	2.89	14.02	70.13
SC246	Little Ark R, Alta Mills	720	5.1	9.4	20	57	300
SC705	Black Kettle Cr	77	0	.34	1.79	5.53	17.51
SC703	Kisiwa Cr	119	2.75	4.93	9.26	18.62	42.6
SC534	Emma Cr	175	.71	2.03	5.54	16.19	49.98
SC535	Sand Cr	104	0	.73	3.22	10.41	32.6
SC282	Lit Ark R, Valley Center	1345	22	38	68	162	695
SC728	Lit Ark R, above confluence w/ Ark R	1404	22	36	67	143	530
SC729	Ark R, Wichita	37914	125	201	396	832	2240
SC281	Ark R, Derby	38000	187	298	533	1090	2560

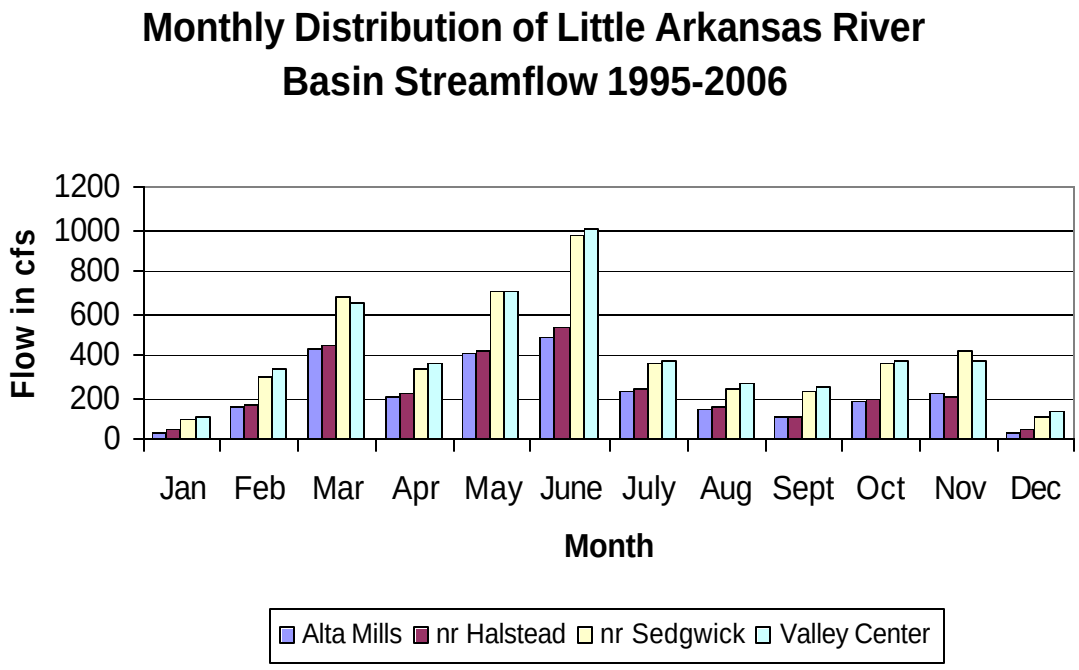
As indicated in Table 1 and Figure 1, streamflows within the Little Arkansas River increase when moving downstream. The high flows associated with these streams are of particular interest when interpreting atrazine impairments because atrazine impairments and exceedances within the stream are primarily caused by runoff from heavy rainfall after the herbicide application. High flows transport atrazine from the upland fields downstream to the on-stream monitoring stations.

Figure 2. Comparisons of flow durations at the USGS stations along the Little Arkansas River.



Data associated with the sampling stations within the watershed has been divided into two categories for interpretation, the runoff period and the non-runoff period. The runoff period includes the months of April, May, June, and July, where runoff and atrazine applications are likely to occur. The non-runoff period accounts for months outside the runoff season. Streamflows enter the spring period with a slight decrease between March and April as indicated in Figure 2. Flows then increase substantially in the two months following April. As summer conditions develop in July and August, flows decrease to pre-runoff levels, then continue to decline into autumn and winter. The three-runoff months of May, June, and July are the period of highest risk in applying herbicides on land surfaces.

Figure 3. Monthly average flow measurements at USGS stations along the Little Ark R.



Since KDHE sampling occurs bimonthly and without consideration of rainfall events or atrazine application dates, the KDHE data sets typically miss the frequency and magnitude of elevated atrazine levels within the watershed, particularly if samples were not obtained after a runoff event. USGS samples obtained on the Little Arkansas River near Halstead and Sedgwick will reflect much higher atrazine averages and concentrations since these samples occur more frequently, particularly in consideration with runoff events. During a runoff event USGS has sampled the site several times within a few days to capture the movement of the atrazine load associated with the runoff event. During typical flow conditions throughout the year USGS obtained routine samples, which typically had minimal atrazine detections since these periods are not associated with runoff or atrazine application. Since USGS conducted several sampling events during runoff events, the atrazine averages associated with these sampling stations is considerably higher than the KDHE sampling stations.

Table 3. Average April through July Atrazine Concentrations (ppb) for KDHE and USGS sampling stations.

Station	Stream	Atrazine Avg. All Data (ppb)	Atrazine Avg. April-July (ppb)	Atrazine Avg. Aug-March (ppb)	Max Atrazine (ppb)
SC533	Turkey Creek	1.2	3.11	~0.35	7 (6/19/02)
SC246	Little Ark R, Alta Mills	1.23	2.2	~0.95	11 (5/18/05)
USGS 07143672	Lit Ark Hwy 50 nr Halstead	5.46	7.05	0.75	46.2 (6/14/97)
SC705	Black Kettle Cr	1.26	2.3	~0.57	2.8 (5/3/95)
SC703	Kisiwa Cr	3.58	4.72	<0.3	13 (6/19/02)
SC534	Emma Cr	2.03	6.05	<0.3	9.2 (7/13/94)
SC535	Sand Cr	1.75	4.95	~0.33	7.6 (7/8/98)
USGS 07144100	Lit Ark R nr Sedgwick	5.93	7.51	0.94	48 (5/13/04)
SC282	Lit Ark R, Valley Center	1.74	3.7	~0.64	17 (5/18/05)
SC728	Lit Ark R, above confluence w/ Ark R	2.19	5.29	~0.79	16 (5/18/05)
SC729	Ark R, Wichita	2.21	5.67	~0.32	16 (5/17/05)
SC281	Ark R, Derby	1.55	3.11	~0.57	14 (5/17/05)

As seen in the following Figures (4-8), the atrazine concentrations are significantly higher during the runoff period months of April, May, June, and July due to the prevalent use of atrazine during this time period and because of the susceptibility to heavier rainfall events that contribute runoff.

Figure 4. Monthly distribution of atrazine along at SC533 and SC246.

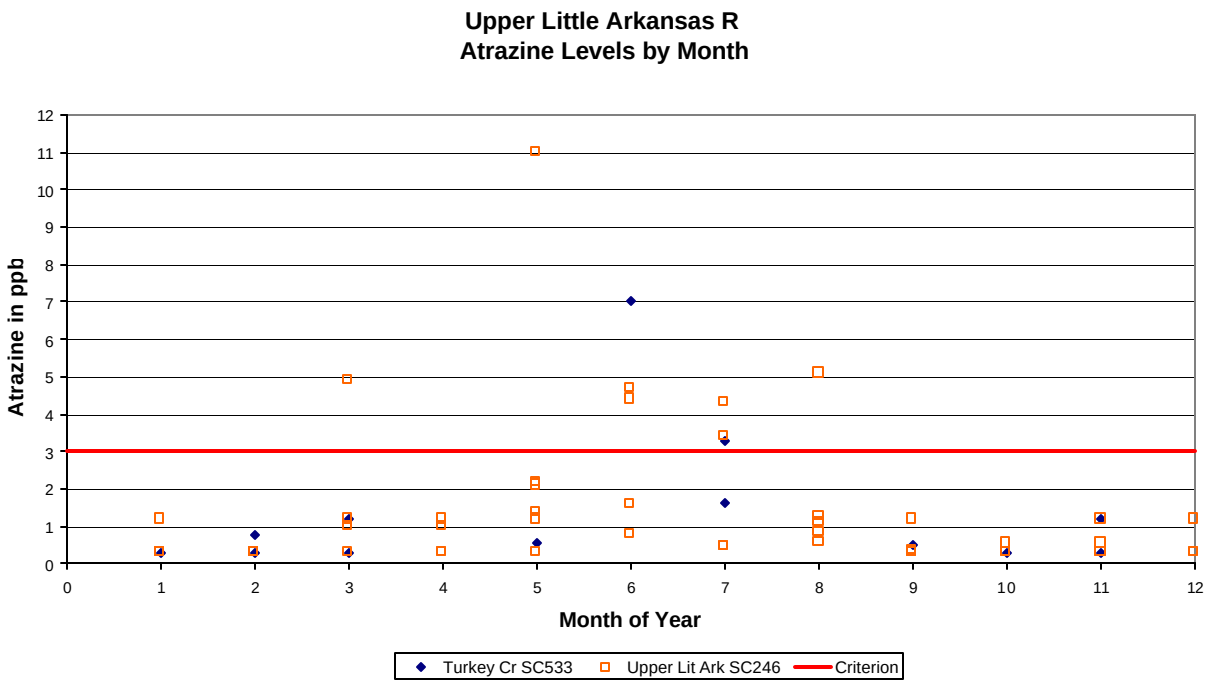


Figure 5. Monthly distribution of atrazine at USGS station 07143672.

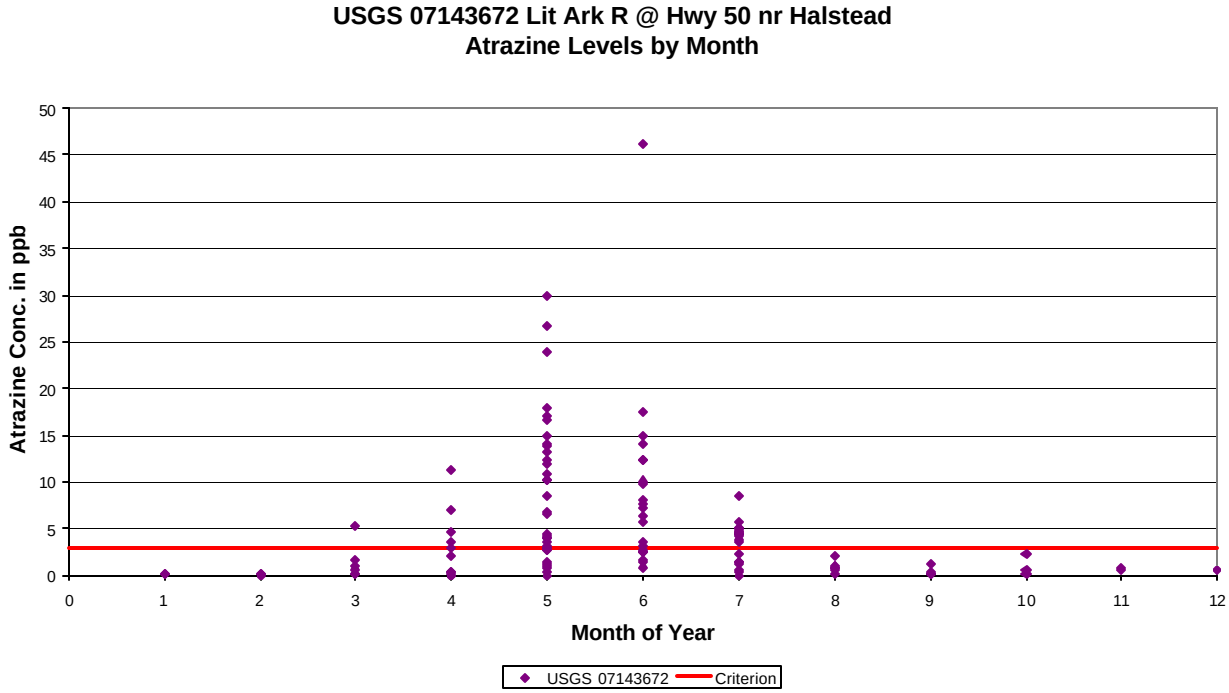


Figure 6. Monthly distribution of atrazine along selected tributaries.

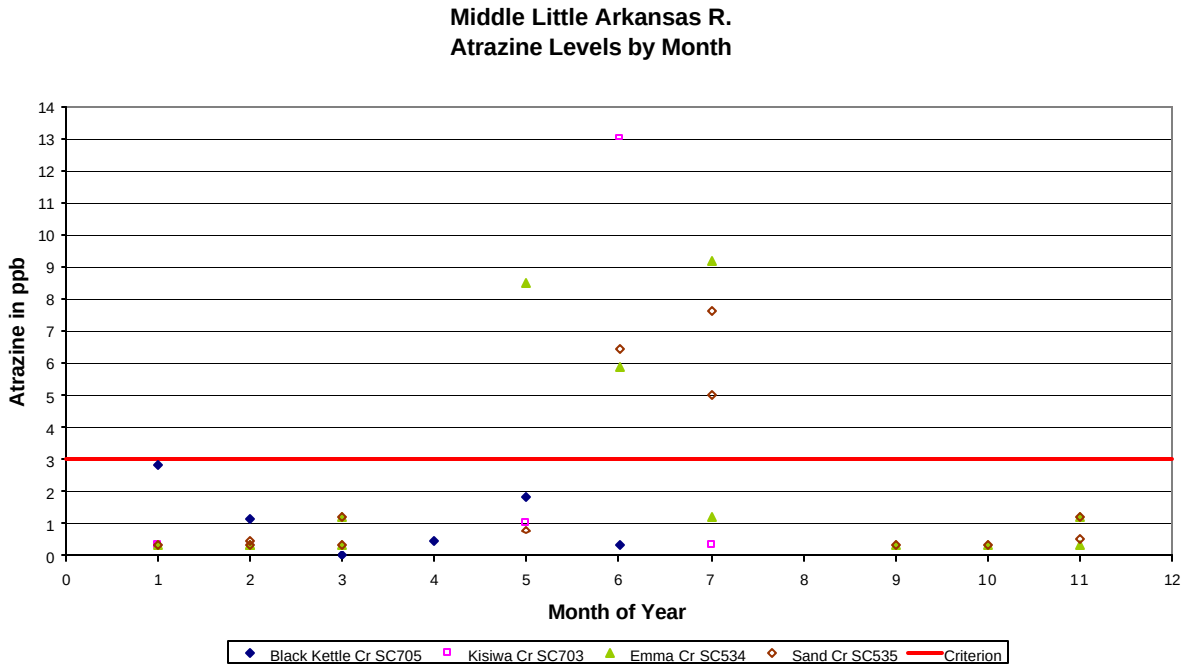


Figure 7. Monthly distribution of atrazine at USGS station 07144100.

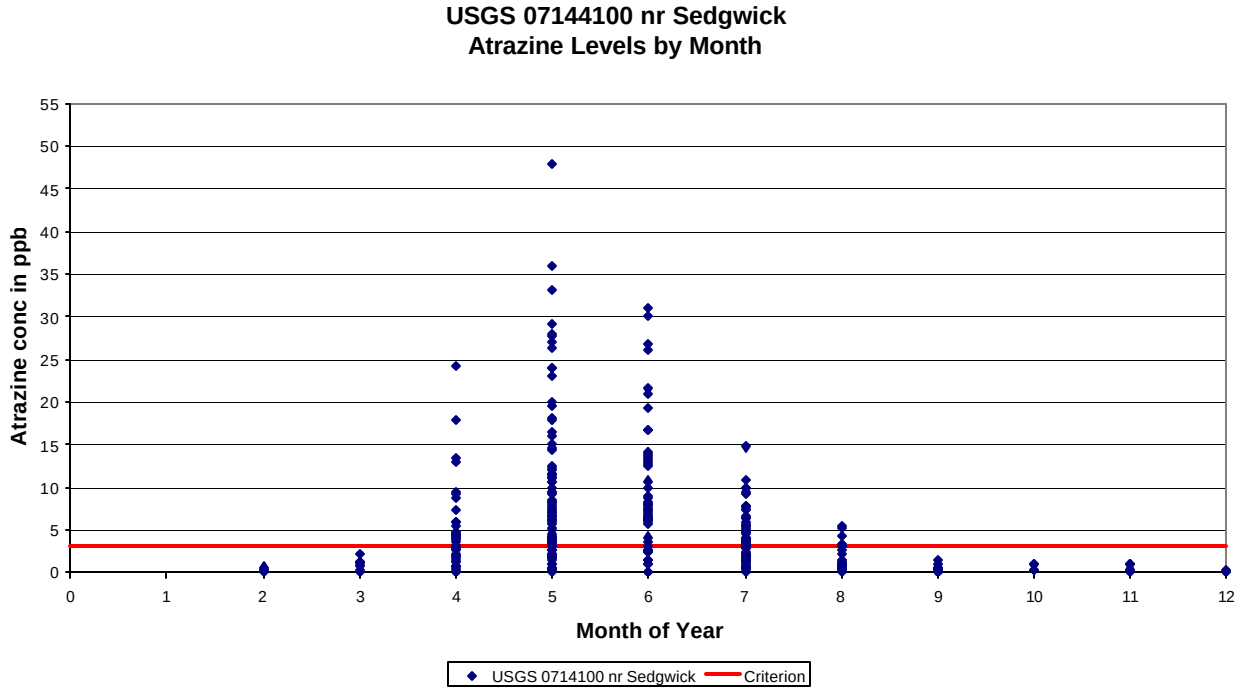
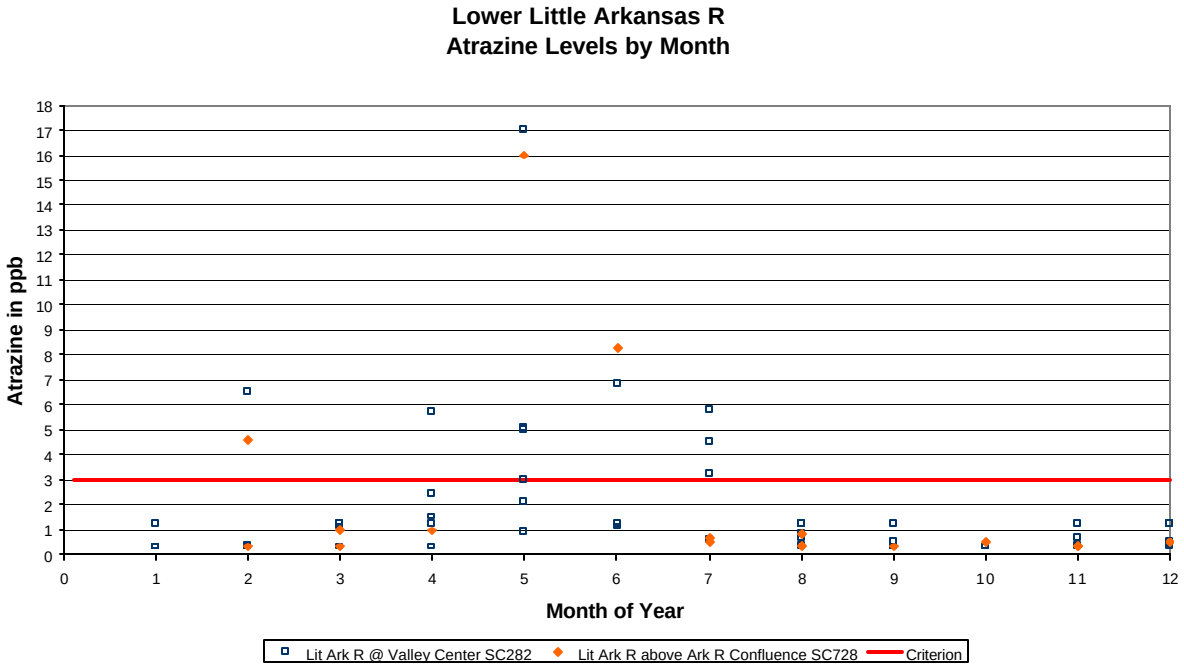


Figure 8. Monthly distribution of atrazine at SC282 and SC728.



As displayed in the following Figures (9-13), atrazine excursions are also observed at lower base flow conditions. This may be due to improper application practices, past runoff flow recession preceded the sampling date, or irrigation tailwater.

Based on a review of the daily flow conditions for low flow digressions, high atrazine at low flow results from two extended sampling runoff recession scenarios. During a high flow event the streams will rise and increase their bank storage capacity. After the runoff crests, flows decrease and bank storage with high atrazine levels drains into the stream. Under this scenario, the bank storage discharge may release high atrazine concentrations for several weeks after a significant runoff event. A second scenario indicates very low flows for days prior to the excursion but the flows increase two-fold on the sampling day, indicating a brief but high intensity runoff event. The second scenario may still be classified as a low flow condition, however the atrazine concentration from a brief runoff event could be significant if the application was recently applied. The majority of the exceedances occurring during lower flow conditions occurred during the late 1980s. During this time, the application rates were greater than present and Best Management Practices (BMPs) were not widely utilized.

Figure 9. Atrazine Concentrations at SC533 and SC246 at Ambient Flow Condition

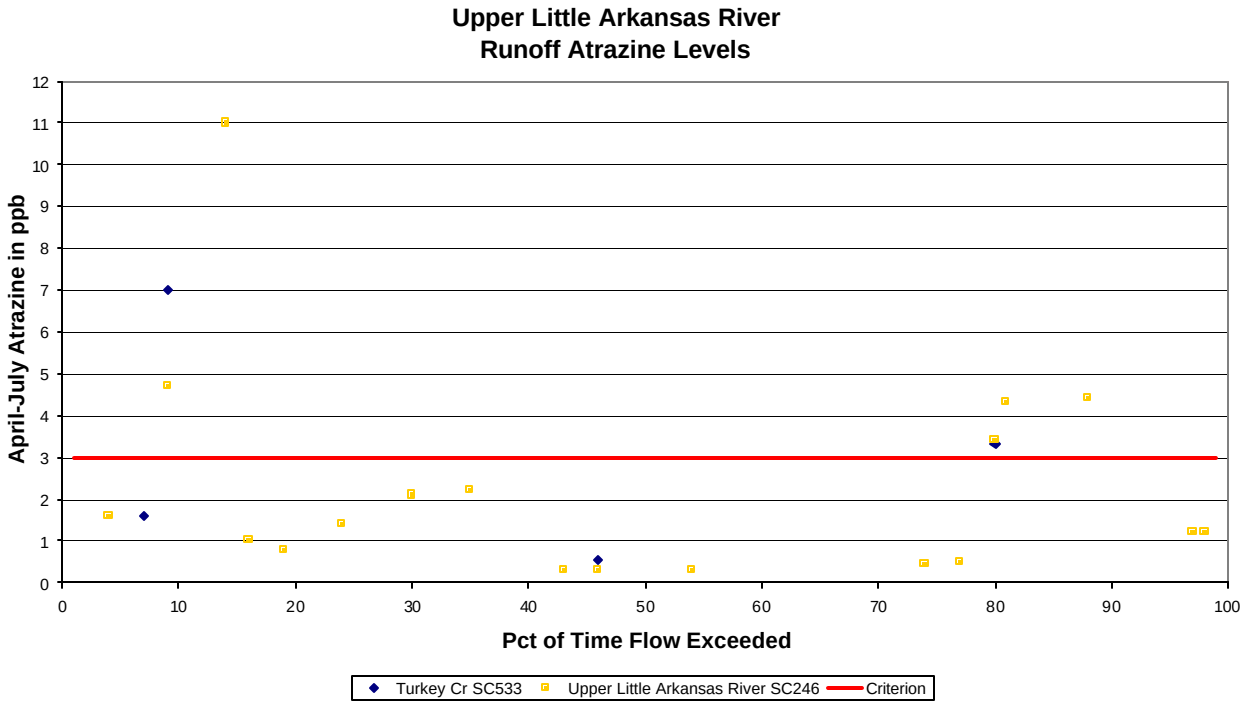


Figure 10. Atrazine Concentrations on Little Ark R. at Ambient Flow Condition

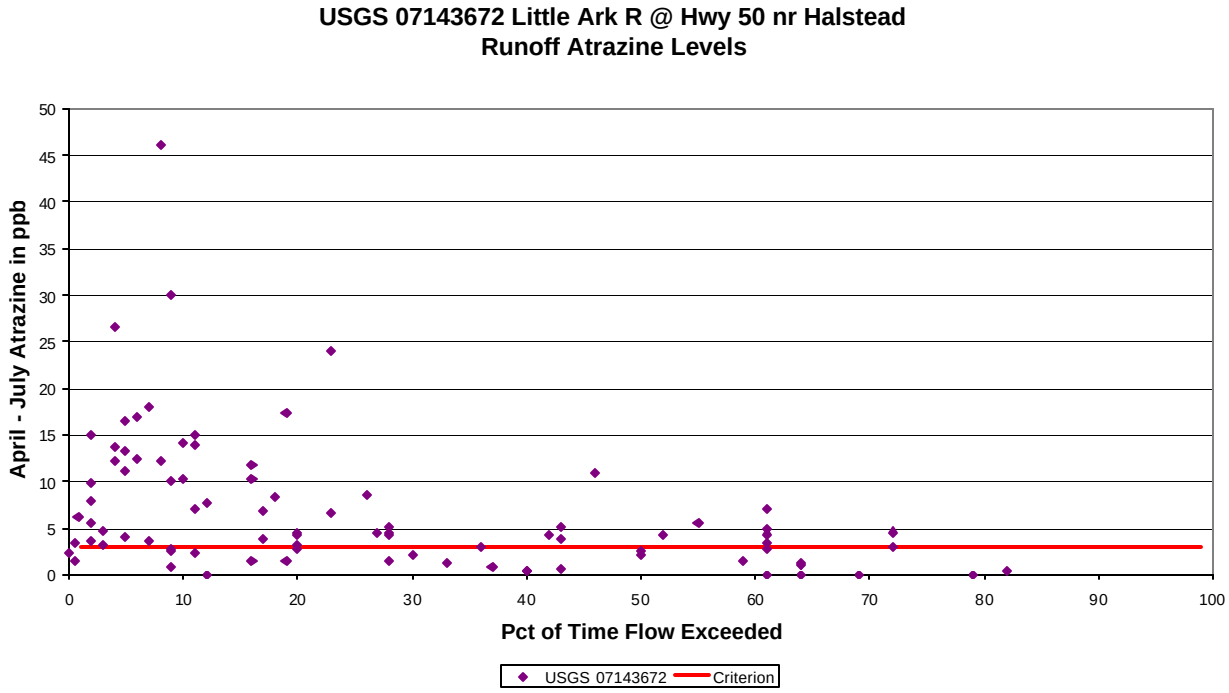


Figure 11. Atrazine Concentrations on Little Ark R. tributaries at Ambient Flow Condition

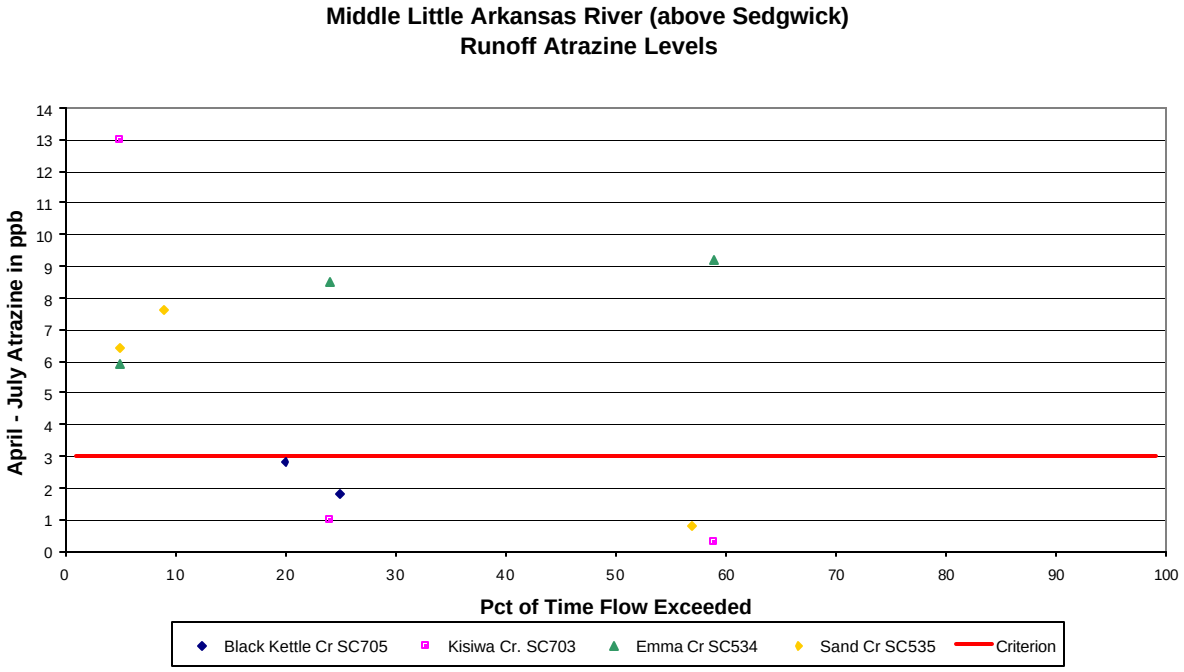


Figure 12. Atrazine Concentrations on Little Ark R. at Ambient Flow Condition

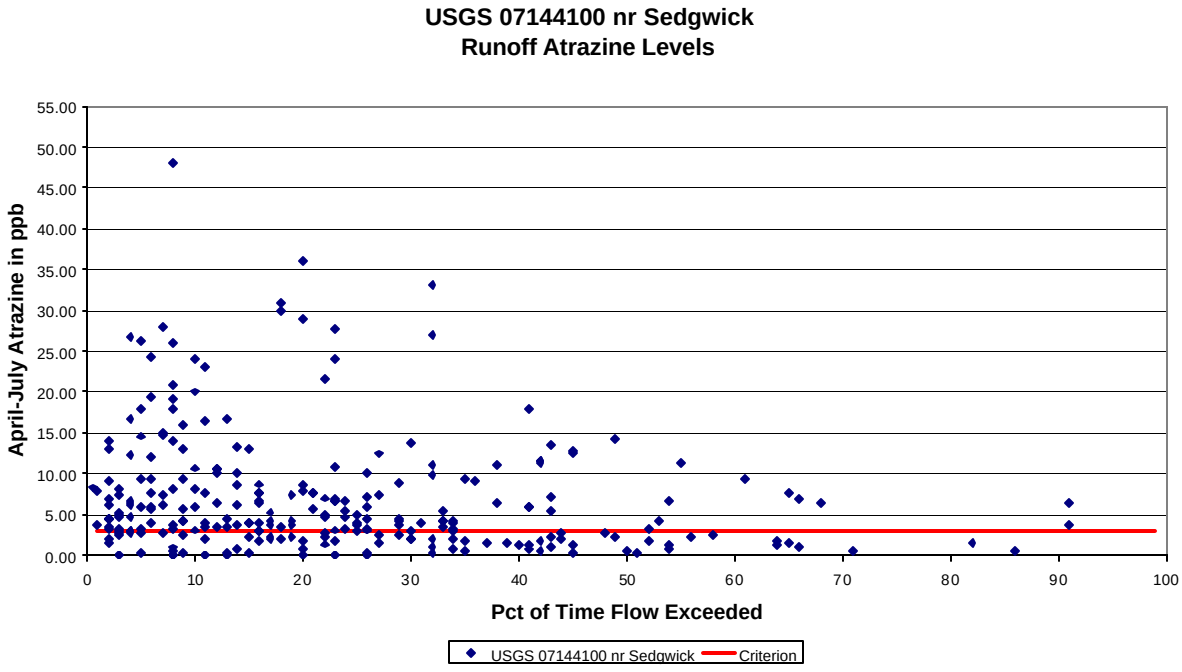
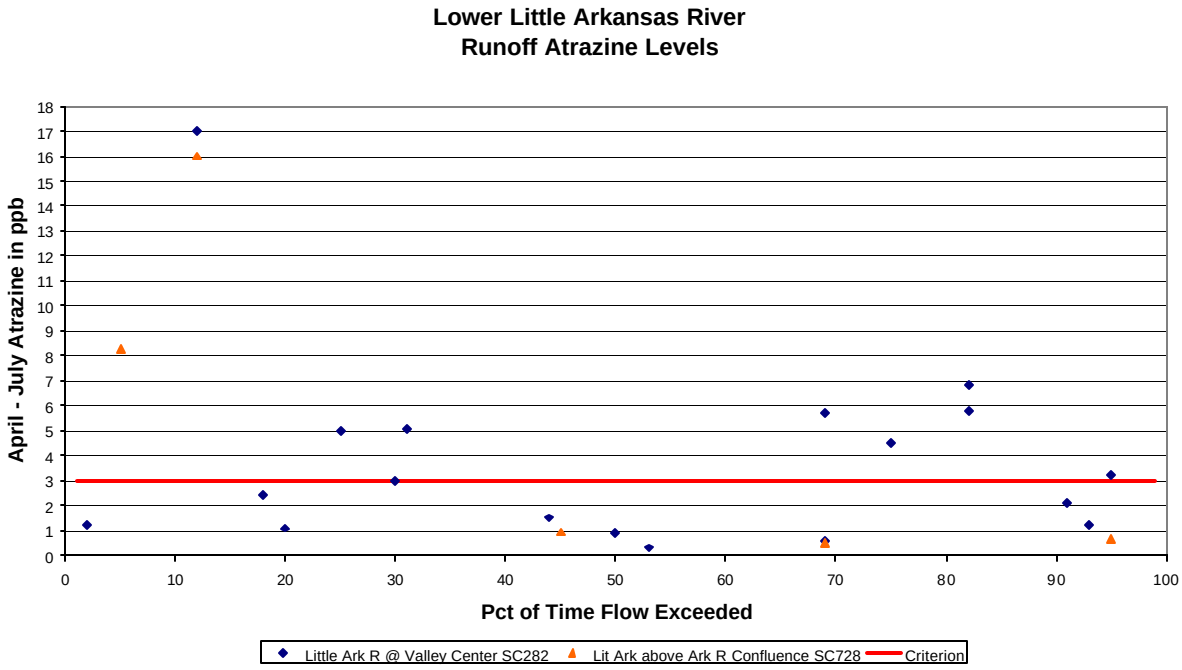


Figure 13. Atrazine Concentration on Little Ark R at Ambient Flow Condition



Tributaries and their drainage areas in the Little Arkansas River watershed that have contributed significant atrazine concentrations and loads to the watershed have considerable acreage of row crops, including corn and sorghum. There were no atrazine excursions observed in the non-runoff period for any of the tributary monitoring stations. A brief summary of the tributary data (Table 4) and the level of concern the tributary has on the watershed as a whole is as follows:

Turkey Creek: The drainage basin for Turkey Creek is of concern as 50% of the samples collected during the runoff period were over the water quality standard. This area of concern includes areas within McPherson County and consists of the largest drainage area of any of the tributaries adjoining the Little Arkansas River.

Black Kettle Creek: There have been no excursions observed in samples collected in Black Kettle Creek, which accounts for the smallest contributing drainage area to the watershed.

Kisiwa Creek: The drainage basin contributing to Kisiwa Creek is of concern due to the runoff period atrazine average of 4.72 ppb. This portion of the watershed consists of western Harvey and eastern Reno counties.

Emma Creek: Emma Creek primarily drains north central and central Harvey and southeastern McPherson counties and is of considerable concern since 75% of the runoff period samples were over the criterion and the atrazine runoff period average of 6.05 ppb,

is the highest of any of the tributaries in the watershed. In addition Emma Creek is currently listed as a Category 5 impaired stream on the 2004-303(d) list.

Sand Creek: Sand Creek drains much of eastern Harvey and southwestern Marion counties. The drainage area for Sand Creek, like Emma Creek, is of considerable concern since 75% of the runoff period samples were over the criterion. Sand Creek is also currently listed as a Category 5 impaired stream on the 2004-303(d) list.

Table 4. Data Summary for Tributaries.

Station	Creek	Total # of Samples	Total Samples > 3 ppb	% of Total > 3ppb	# of Runoff Period Samples	# of Runoff Period Samples > 3ppb	**% of Runoff Period > 3 ppb**
SC533	Turkey Cr	13	2	15%	4	2	**50%**
SC705	Black Kettle Cr	5	0	0%	2	0	**0%**
SC703	Kisiwa Cr	4	1	25%	3	1	**33%**
SC534	Emma Cr	13	3	23%	4	3	**75%**
SC535	Sand Cr	13	3	23%	4	3	**75%**

There are considerably more data available for review from the major sampling points along the main stem of the Little Arkansas River. As indicated in Table 5, numerous digressions from the water quality criterion of 3 µg/l were observed at both the USGS and KDHE sampling stations during the runoff period from April through July. KDHE Station 246 at Alta Mills and the USGS Station 07143672 near Halstead are geographically close. However, since the USGS sampling frequency was inclined to catch runoff events, the lower percentages of samples greater than 3 ppb and the lower concentration averages at Station 246 may be understated. This also holds true downstream in comparing the USGS Station 07144100 data near Sedgwick with the KDHE Station 282 data from Valley Center. Atrazine detections above the criterion were for the most part restricted to the runoff period, as 92% of the samples obtained during the non-runoff period had concentrations below the criterion. Atrazine levels during the spring are sufficiently high that annual average atrazine concentraions on the Little Arkansas River are over 3 µg/l, which is evidence of impairment of the Domestic Water Supply use of the river.

The upper portion of the watershed above the USGS sampling station near Halstead, which includes the Little Arkansas River above Alta Mills and Turkey Creek, is susceptible to atrazine digressions in May, June and July. Atrazine excursions greater than 3 ppb have been observed in more than 50% of the samples for April, May, June, and July at the downstream USGS sampling station near Sedgwick. With the proximity of the KDHE sampling station at Valley Center (Station 282) to the Sedgwick station, atrazine concentrations at Valley Center are also likely of concern during these four months as well.

Table 5. Little Arkansas River monthly comparisons of atrazine detections.

Station	Location	Month	# of Samples	# of Samples > 3 ppb	% of samples over 3 ppb	Monthly Atz Avg. in ppb
SC246	Alta Mill	April	4	0	0%	0.70
		May	6	1	17%	3.22
		June	4	2	50%	2.87
		July	4	2	50%	2.16
		Aug-Mar	32	2	6%	0.85
USGS	Hwy 50	April	11	5	45%	2.98
07143672	Nr Halstead	May	34	25	74%	8.99
		June	22	15	68%	8.76
		July	21	14	67%	3.58
		Aug-Mar	29	1	3%	0.75
USGS	Sedgwick	April	44	26	59%	4.72
07144100		May	95	75	79%	9.28
		June	53	42	79%	9.52
		July	66	37	56%	4.07
		Aug-Mar	72	5	7%	0.94
SC282	Valley	April	5	1	20%	2.22
	Center	May	6	3	50%	5.51
		June	3	1	33%	3.03
		July	4	3	75%	3.51
		Aug-Mar	32	1	3%	0.83

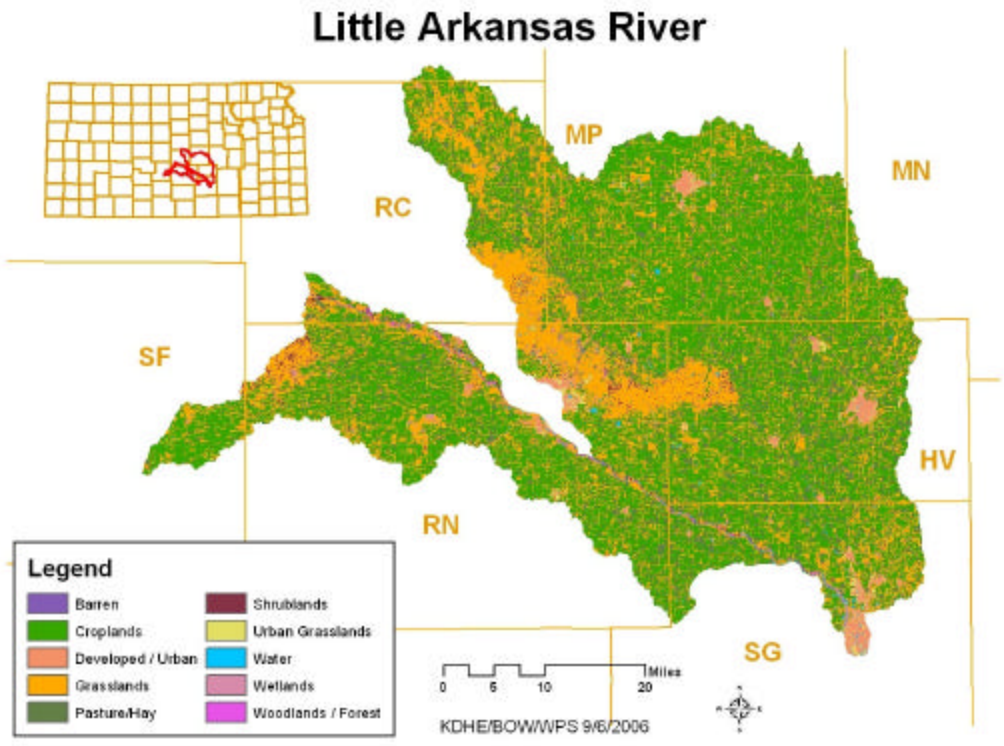
Based on the current agricultural practices in the watershed, there is economic value associated with the application of atrazine to specific crops. Atrazine has been widely utilized since the 1960's for selective control of broadleaf and grass weeds in corn and grain sorghum. Because of its high solubility in water, atrazine is susceptible to removal from cropland during overland runoff events. As seen in Table 6, there are a considerable amount of acres within the watershed that are utilized for the production of these crops associated with atrazine usage.

Table 6. 2004 Kansas Farm Facts by acres planted, for counties in the Little Arkansas River watershed

County	*Sorghum*	*Corn*	*Soybeans*	*Wheat*	*All Hay & Pasture*
McPherson	65,500	22,900	30,800	219,000	38,600
Marion	65,700	18,300	30,200	132,000	74,600
Rice	66,000	19,600	30,000	150,000	29,100
Harvey	64,400	32,400	34,600	118,500	25,400
Reno	26,600	28,900	36,000	248,900	42,500
Sedgwick	63,200	28,600	38,500	196,000	54,200

Within the Little Arkansas watershed, atrazine digressions have typically occurred as a result of agricultural usage in McPherson and Harvey counties (Figure 14). By targeting McPherson and Harvey counties, both short-term and annual average concentrations of atrazine should remain below 3 µg/l to support Aquatic Life, thus supporting the Domestic Water Supply use of the river. These Water Quality Standards will be achievable with the implementation strategies outlined in this 4B Alternative.

Figure 14. Land Use Map



3. Implementation Strategy

As indicated in the Figures 15-18, atrazine loads exceed the permissible atrazine load at high flows (exceeded less than 35% of the time) during the runoff season, of April through July. Generally, rains of more than half an inch falling on the watershed spurs some digressions in some of the streams. A one-inch rain tends to trigger atrazine loading throughout the watershed. The actual timing of the atrazine application in each sub-watershed, the localized rainfall over each stream, the slope and soil conditions in each sub-watershed and the impact of any pesticide/herbicide BMPs utilized by individual farmers complicates the true relation between rain and atrazine loading across the watershed.

Since atrazine is associated with agricultural non-point source pollution, point sources are not of concern under this 4B Alternative. At most moderate rainfalls, McPherson and Harvey counties will likely account for the majority of the atrazine loading.

The water quality targets for the 4B alternative are to achieve lower annual averages and fewer excursions over 3 ppb. Since atrazine application is often performed based on the extended weather forecasts, it is inevitable that overland runoff events will occur on occasion despite careful application planning. When excursions do occur, the goal is to limit these to brief periods in May and June.

Figure 15. Atrazine loads and permissible loads on Little Ark R at Alta Mills-SC246.

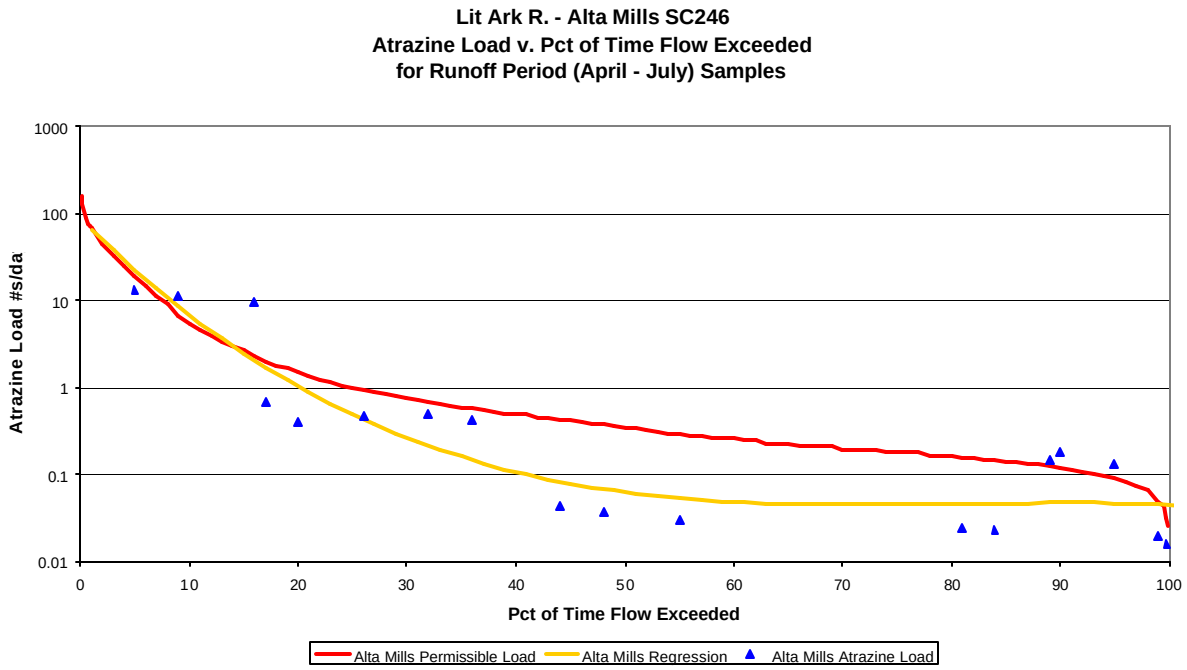


Figure 16. Atrazine loads and permissible loads on Little Ark R nr Halstead.

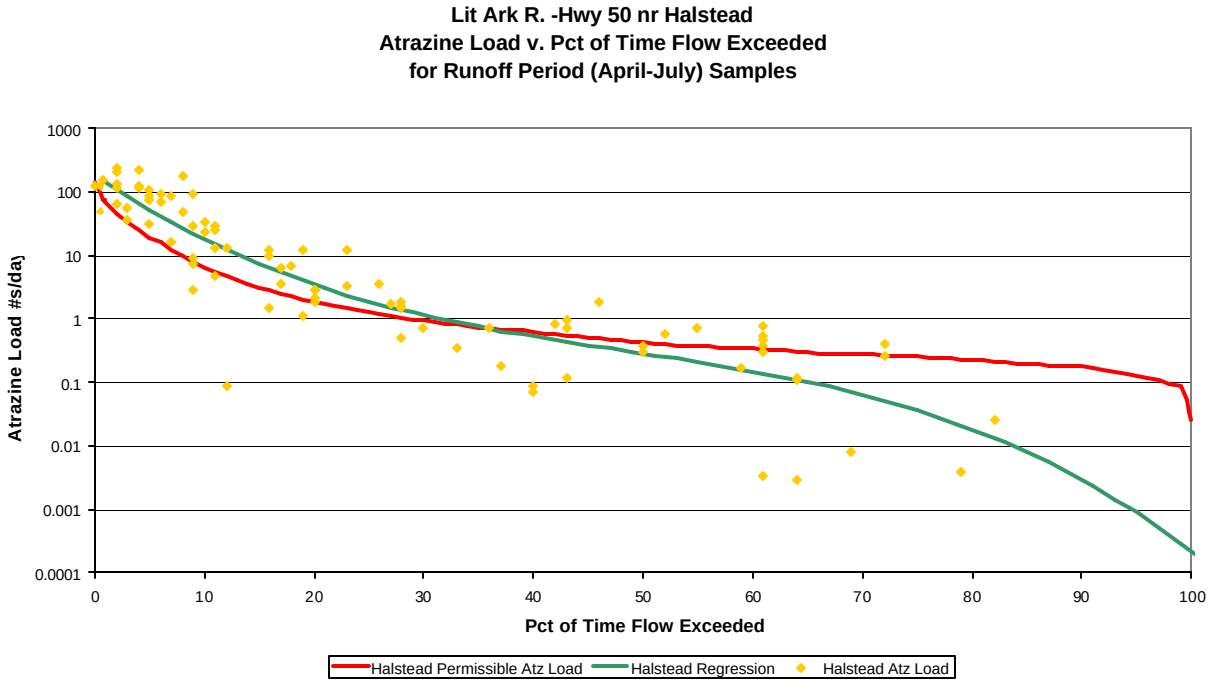


Figure 17. Atrazine loads and permissible loads on Little Ark R nr Sedgwick.

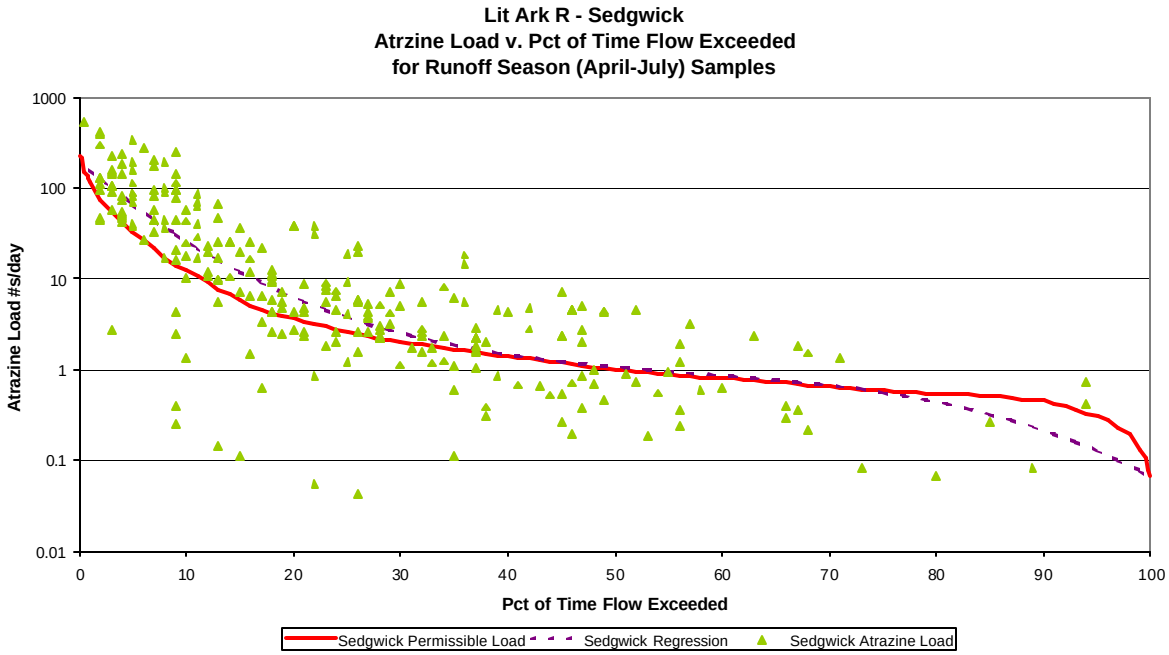
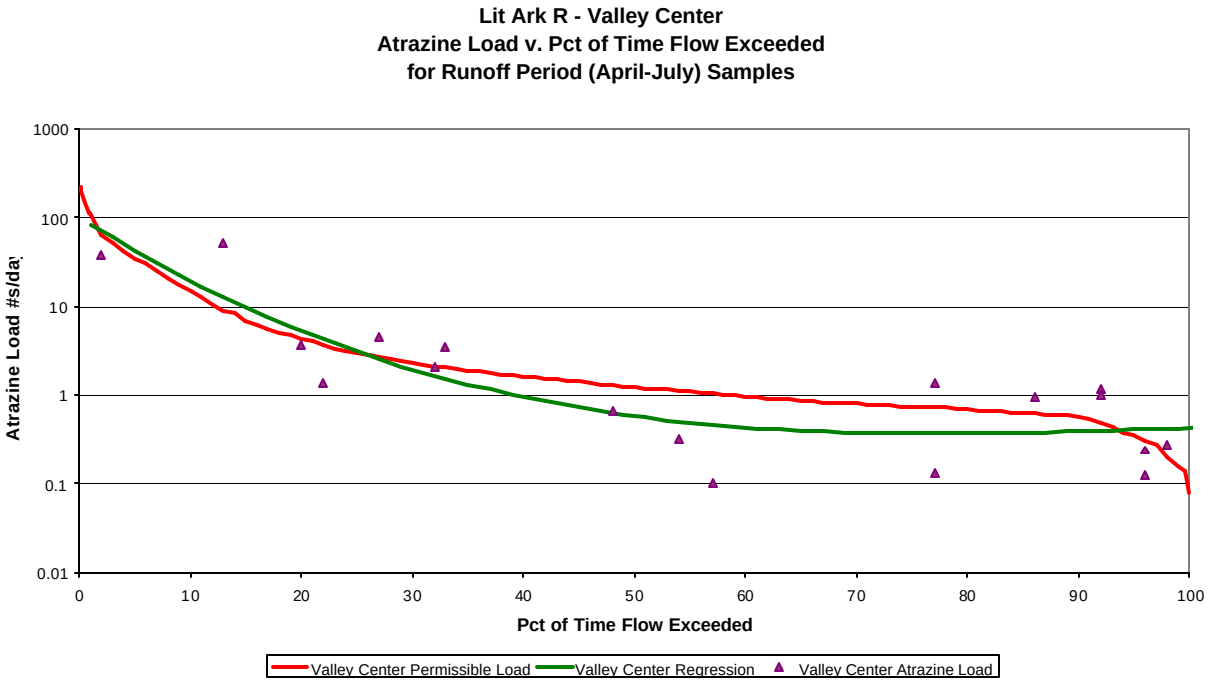


Figure 18. Atrazine loads and permissible loads on Little Ark R at Valley Center-SC282.



Non-point Source Loadings: The Load Allocations for atrazine will be established based on the data from USGS sampling stations near Halstead and Sedgwick along the Little Arkansas River and will be expressed as percent reductions from current seasonal average loads. The percentile reductions will be carried forward to the local KDHE sampling stations along the Little Arkansas River since the KDHE stations are still actively being sampled. The USGS sampling locations near Halstead and Sedgwick continue to be utilized for streamflow measurements. Therefore load allocations developed for the USGS 07143672 station near Halstead will apply to KDHE station SC246 in Alta Mills and load allocations developed for Sedgwick will apply to KDHE station SC282 at Valley Center. By utilizing the reductions based on the USGS data, the percentage of loading reductions will accurately reflect the necessary conditions to achieve the Water Quality Standard throughout the watershed.

Reductions to meet the Load Allocation assigned to the Upper Little Arkansas River represented by the USGS 07143672 station near Halstead, and KDHE station SC246, lie with non-point source contributors in eastern Rice, northeastern Reno, McPherson and northwestern Harvey County. Current average May-July loads need to be reduced by 50% at KDHE station SC246.

Table 7. USGS Sampling Station Runoff Period Atrazine Loadings & Necessary Reduction on the Little Arkansas River.

Sampling Station	Stream Location	Month	Atrazine Avg. in ppb	Monthly Avg. Flow in CFS	Avg. Load in #s/day	Load Reduction (%)
USGS 07143672	Little Arkansas R Hwy 50 nr Halstead	May	8.99	407	19.75	67%
		June	8.76	485	22.9	66%
		July	3.58	233	4.5	17%
		May-July Avg of Actual Pct Reductions				**50%**
USGS 07144100	Little Arkansas R nr Sedgwick	April	4.72	344	8.77	37%
		May	9.28	700	35	68%
		June	9.52	973	50	69%
		July	4.07	367	8.1	27%
		April-July Avg. Actual Pct Reductions				**50%**

Load reductions along the Lower Little Arkansas River above Wichita are the responsibility of non-point source contributors within Harvey, northern Sedgwick, and southeastern McPherson counties. The month of April was also included as a month of interest for the lower portion of the watershed since atrazine concentrations averaged above the criterion for samples obtained during this month. Current average April-July loads are to be reduced by 50% at KDHE stations SC282. Station SC728 near the mouth of the Little Arkansas River and station 729 on the Arkansas River below the confluence will be used to confirm improved water quality.

Tributary Loads: Due to the lack of data available from the KDHE rotational sampling stations, load reduction estimates were assigned to the respective tributaries and their corresponding sampling stations based on the actual excessive load averages assigned to the corresponding USGS stations along the Little Arkansas River downstream of the tributary. Table 8 illustrates the average and maximum atrazine concentrations at the respective rotational stations during the runoff season and the associated loadings. Table 9 displays the load contribution and reduction ranges for the average and maximum atrazine concentrations for the respective tributary sampling stations during the runoff period along with the 4B desired average load reduction.

Table 8. May-July estimated Average and Maximum Atrazine Loadings.

KDHE Station	Stream	Estimated Mean Daily Flow	Runoff Period May-July Atz Avg. Conc.	Runoff Period May-July Atz Max Conc.	Estimated Avg Load Contribution #s/day	Estimated Max Load Contribution #s/day
SC533	Turkey Cr	62.4	3.11	7	1.05	2.36
SC705	Black Kettle Cr	17.4	2.3	2.8	0.22	0.26
SC703	Kisiwa Cr	31.7	4.72	13	0.81	2.23
SC534	Emma Cr	43.1	6.05	9.2	1.41	2.15
SC535	Sand Cr	29	4.95	7.6	0.78	1.19

Table 9. May-July Load contributions and 4B Desired Loading Reductions.

KDHE Station	Stream	Estimated Runoff Load Contribution #s/day	% Load Reduction Range during Runoff Period	**4B % Desired Avg. Load Reduction during Runoff Period**
SC533	Turkey Cr	1.05-2.36	4-57%	**50%**
SC705	Black Kettle Cr	0.22-0.26	0%	**0%**
SC703	Kisiwa Cr	0.81-2.23	37-77%	**50%**
SC534	Emma Cr	1.41-2.15	50-68%	**50%**
SC535	Sand Cr	0.78-1.19	40-61%	**50%**

The 4B Alternative desired load reduction for all tributary streams within the watershed is 50% on average during May-July, with the exception of Black Kettle Creek. Since Black Kettle Creek does not contribute significant loads and has not had any water quality violations there will be no load reduction applied to this stream. The 50% atrazine load reduction assigned to the tributaries is based on the comparison of the estimated average and maximum load contributions for each stream and consistent with the reduction goals for the Little Arkansas River. While there have been no samples collected during the month of April for any of the tributary sampling stations, April is a month of concern for the lower portion of the watershed, therefore there should be no excursions in April on Kisiwa Creek, Emma Creek, and Sand Creek.

Controls: The best way to reduce atrazine loading caused by agricultural practices is to ensure that Best Management Practices (BMPs) are being implemented within the watershed. In addition, it is important to educate the agricultural community on atrazine application rates, timing, alternatives, and label instructions. Kansas State University (KSU) conducted a survey of landowners and agribusiness personnel in 2003 on cropping practices within the Little Arkansas watershed. The survey concluded that reduced or no-tillage practices were used minimally in the watershed and that most corn and grain sorghum acres in the watershed have atrazine applied to them. The Kansas State Extension Office has numerous publications available that will assist in the implementation of BMPs throughout the watershed. In addition, several of the BMPs have been targeted for implementation through the ongoing Watershed Restoration and Protection Strategy (WRAPS) project for the watershed.

Atrazine BMPs: Kansas State University (KSU) has identified several effective BMPs that reduce atrazine runoff. The follow BMPs have been recommended by KSU:

1) *Soil Incorporation*: Atrazine runoff could be reduced by approximately 67% by incorporating the atrazine into the top two inches of soil as compared to traditional direct surface application.

2) *Application timing:* The time atrazine is applied to the field could reduce the atrazine runoff by up to 50% if the atrazine is applied prior to April 15th. Applications are more prone to runoff as rainfalls intensify in the following months of May and June.

3) *Split Applications:* Atrazine runoff could be reduced by up to 33% if the application is split into two applications, with the first being applied in early spring and the second being applied when the crop is planted. The total amount applied between the split applications should not exceed the amount applied during one traditional application.

4) *Reduced soil-applied rates*: Atrazine rates could be reduced by up to 33% by selecting herbicides that contain less atrazine. KSU has identified several alternative brands that effectively control weeds and contain less atrazine.

5) *Postemergence applications of atrazine:* A variety of herbicides are available that could be applied after the crops have emerged, which could reduce atrazine runoff by 67%, as these contain much lower rates of atrazine.

6) *Combine surface applications with postemergence atrazine:* Atrazine runoff could be reduced by 25% by reducing soil-applied rates (not to exceed 1 lb atrazine per acre) at planting time followed by a postemergence application. The method is effective for difficult broadleaf weeds.

7) *Alternative herbicides or nonchemical weed control methods:* The use of newer herbicides that contain no atrazine will eliminate atrazine runoff. In addition, rotating crops, cultivation and nonchemical weed control methods may be effective at reducing the need for herbicide applications.

8) *Vegetative filter strips:* Atrazine loss could be reduced by 25% if sufficient vegetation is planted along the crop field border to filter the runoff water.

9) *Band application:* The amount of atrazine applied to the field could be reduced by up to 67% if it is applied by banding it over the row at planting or cultivation rather than broadcasting it over the entire field.

10) *Buffer Zones*: Atrazine should not be applied near environmentally sensitive areas or near surface waters. Buffer zones should be created to protect these areas.

Critical Target Areas for Controls: The critical areas identified for the implementation of Best Management Practices to control atrazine runoff and stream loadings are targeted for rowcrop cropland adjacent to the Little Arkansas River and the tributaries of Turkey Creek (to include Dry Turkey Creek), Kisiwa Creek, Emma Creek, and Sand Creek. In addition, rowcrop cropland that may not be adjacent to the immediate stream, but contains waterways or gullies that directly flow to these streams is also an important target for the implementation of BMPs.

WRAPS: In January of 2002, a watershed stakeholder committee consisting of farmers, urban residents, and other citizens within the watershed was formed with the goal of developing and implementing a WRAPS for the Little Arkansas River watershed. The WRAPS process would ensure that the waters not meeting the water quality standards are restored to meet these standards and protect the waters that do meet the water quality standards. The committee and planning effort was lead by a KSU extension watershed specialist that was tasked with developing the draft WRAPS document.

In October of 2004, the Watershed Restoration and Protection Strategy (WRAPS) for the Little Arkansas River watershed was published (see appendix A). This document outlines the restoration and protection goals and actions for the surface and ground waters of the watershed. The Little Arkansas River watershed is currently implementing the WRAPS strategies that have been identified to restore the water quality within the watershed that have been impaired by atrazine. As part of the implementation stage, educational and monetary efforts are being utilized to increase BMPs throughout the watershed to reduce atrazine runoff. The first goal of the WRAPS within the watershed is to "reduce atrazine in water to reach goal of 3 µg/l in surface water, with no seasonal spikes". The WRAPS process has identified that atrazine is applied to 302,022 acres of croplands, of which additional BMPs would be beneficial within the watershed. The implementation target for the WRAPS process is to increase the use of BMPs by 10% for each year for 10 years. This would account for 30,303 acres the first year and ultimately reduce atrazine loads from reaching the surface waters within the watershed. Cost share funding is available for the implementation of BMPs that are projected to significantly reduce the atrazine runoff within the watershed. The primary BMPs incorporated in the cost share program include: split applications of atrazine, incorporating atrazine into the top 2" of the soil, creating buffer zones surrounding the fields, utilizing post emergence herbicide, create terraces with grass waterways and utilizing alternative herbicides that contain less or no atrazine. In addition, some funding is utilized for educating the public on the impact of atrazine within their watershed through various meetings, tours, and demonstrations. The WRAPS process not only identified atrazine as a pollutant of

concern, but also addresses the implementation of BMPs, as well as monetary incentives and cost share programs to help decrease fecal coliform bacteria, nutrient enrichment and sediment in the waters of the Little Arkansas River watershed.

Implementation as outlined in the WRAPS report has begun and has been made possible with funding sources provided from the City of Wichita, the Kansas Soil Conservation Commission and EPA 319-grant money provided through KDHE to KSU. KSU has been selected by the local watershed stakeholder committee to provide research, water quality monitoring, and extension programs for WRAPS implementation activities within the Little Arkansas River watershed. The 319-grant money provided to KSU, in support of the WRAPS implementation, is also being utilized for the development of an extension education and demonstration project in the watershed. In addition, the NRCS has provided federal conservation cost-share funding for watershed practice implementation.

Education and Information Outreach: The Little Arkansas WRAPS group has established a website to communicate information to the stakeholders of the watershed regarding BMP practices, the goals of the WRAPS process, and general information on projects within the watershed that are being implemented as nonpoint source management measures. In addition, the WRAPS group has coordinated public meetings for producers and other stakeholders within their watershed and conducted door-to-door surveys of targeted landowners. The general purpose of these meetings and in home visits is to educate the residents of the watershed on the existing water quality issues, funds available for cost-share incentives for implementing BMPs, and compile producer information on the utilization of existing BMPs.

Requirements for Success: The Little Arkansas watershed stakeholder committee must continue to be proactive with this project and ensure the implementation of the WRAPS project moves forward as scheduled. To ensure the success of the implementation strategies, funding must continue to be available for educational outreach efforts and for cost share programs to reimburse producers for BMPs. In addition, the water quality monitoring and demonstration projects being conducted by KSU are important so producers could make sound economical decisions on the various BMP implementation options and the water quality trends could be documented. Coordination with the atrazine manufacturers, the Kansas Corn Growers Association, and the Kansas Grain Sorghum Producers Association is important so label instructions are clear and appropriate for crops within the watershed. In addition, alternative herbicides may become available or marketed by these organizations that may reduce or eliminate the necessary use of atrazine within the watershed. The pollution control requirements implemented by the WRAPS project is a reasonable approach to meeting the goals of the 4B alternative.

Influence on the Arkansas River: The Little Arkansas River flows into the Arkansas River within the City of Wichita. The atrazine impairments derived from the Little Arkansas River watershed significantly contributes to the impairment of the Arkansas River from Wichita to Derby. The KDHE rotational station in Wichita (SC729) and the

fixed sampling site at Derby (SC281) along the Arkansas River have atrazine impairments consistent with the runoff period months of May, June, and July as displayed in Figure 19.

As seen in Figure 20, atrazine excursions are for the most observed during high flow conditions along the Arkansas River below the confluence with the Little Arkansas River resulting from runoff events from the Little Arkansas River watershed. The excursions that occurred near the median flow conditions are attributed to the slower release of the bank storage discharge or from brief runoff events of shorter duration from the Little Arkansas River watershed

Figure 19. Monthly distribution of atrazine at SC729 and SC281

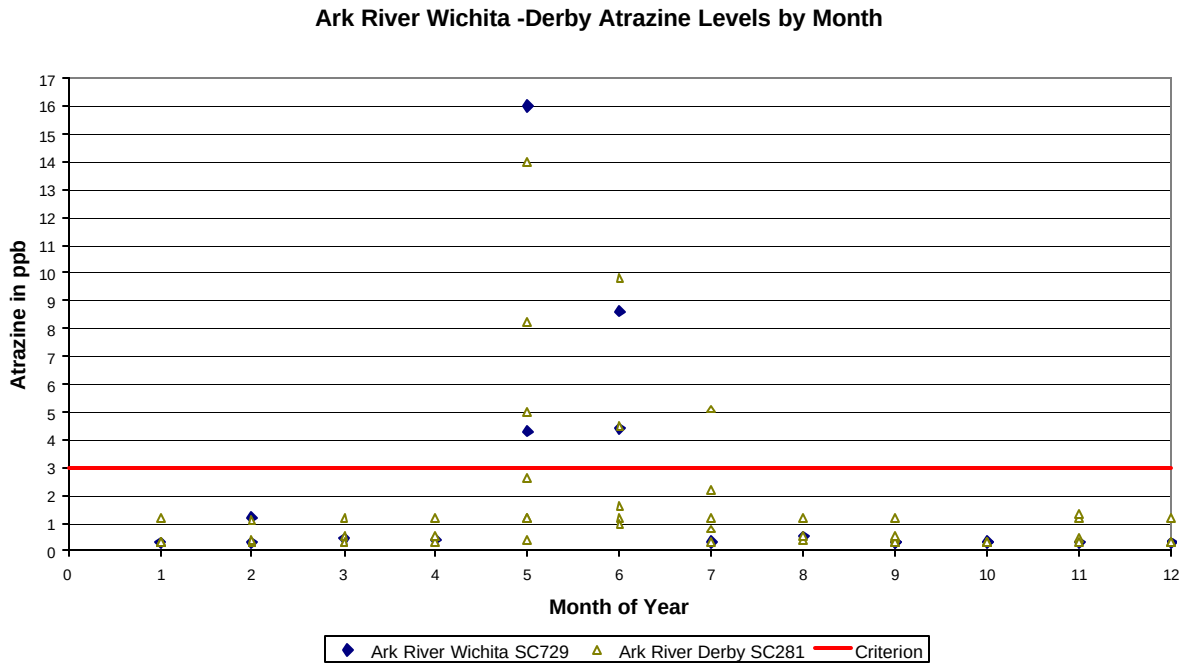


Figure 20. Atrazine Concentration on Ark River at Ambient Flow Condition

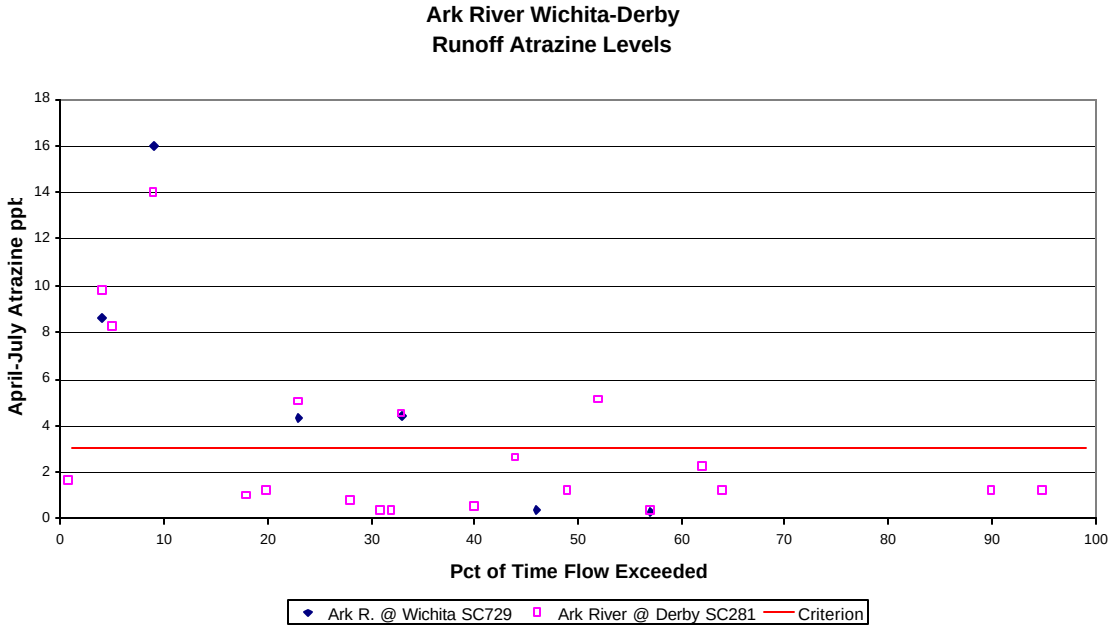
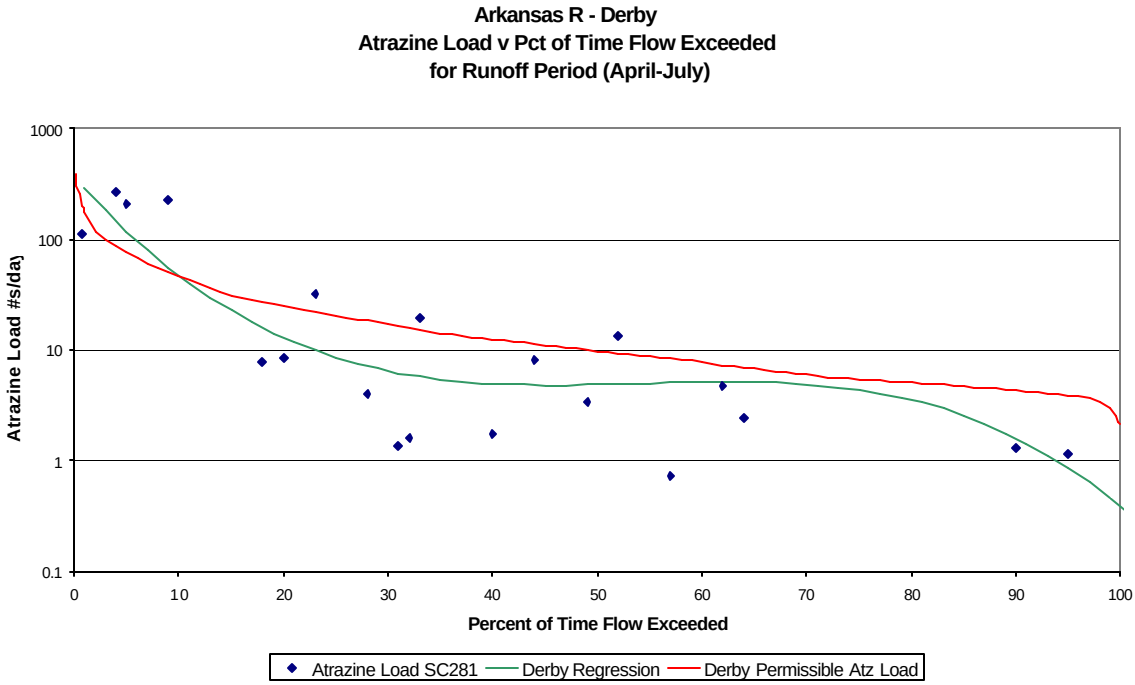


Figure 21. Atrazine loads and permissible loads on Ark R at Derby-SC281



The KDHE fixed sampling station along the Arkansas River near Maize, SC536, is above the confluence with the Little Arkansas River. Data from this site was compared with data collected within the same 24-hour period from the KDHE fixed sampling station along the Arkansas River near Derby (SC281), which is below the confluence with the Little Arkansas River. In addition, the data from the Little Arkansas River fixed sampling site at Valley Center (SC282) was compared to the data from the Arkansas River near Derby (SC281). Though some atrazine concentration within the Arkansas River may be attributed to agricultural areas along the Arkansas River above Wichita, the comparison of the atrazine concentrations between these sites indicates that the primary atrazine impairments within the Arkansas River are directly correlated with the atrazine loads and concentrations derived from the runoff from the Little Arkansas River watershed as illustrated in Figures 22 and 23. The atrazine concentration averages for the Arkansas River are sizably less at Maize in comparison with the averages observed downstream of the confluence with the Little Arkansas River at Derby as seen in Table 10.

Figure 22. Atrazine concentration comparison between Little Ark R. and Ark R for samples collected within same 24-hour period.

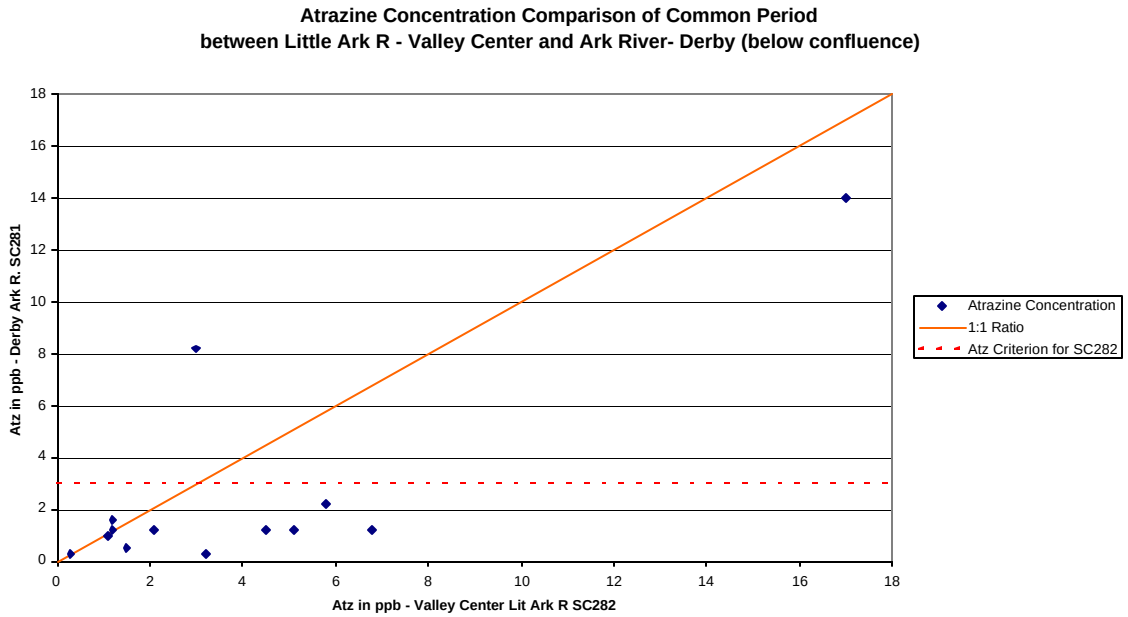


Figure 23. Atrazine concentration comparison between Maize and Derby along Ark R for samples collected during same 24-hour period.

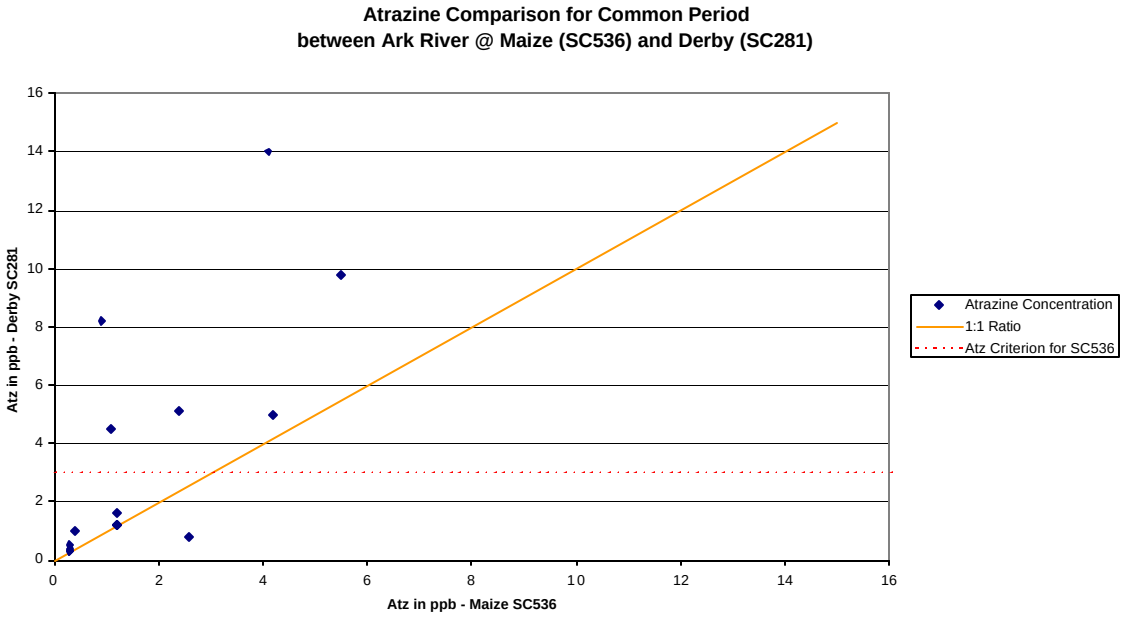


Table 10. Monthly comparison of Arkansas R atrazine data.

Station	Location	Month	# of Samples	# of Samples > 3 ppb	% of samples over 3 ppb	Monthly Atz Avg. in ppb
SC536	Ark River Maize	April	3	0	0%	0.60
		May	5	2	40%	2.14
		June	4	1	25%	2.05
		July	4	0	0%	1.63
		Aug-Mar	32	0	0%	0.55
SC281	Ark River Derby	April	3	0	0%	0.67
		May	7	3	43%	4.65
		June	5	2	40%	3.62
		July	4	1	20%	1.85
		Aug-Mar	32	0	0%	0.57

The atrazine impairment along the Arkansas River from Wichita to Derby will be addressed with the implementation strategies and the atrazine reduction goals associated with the Little Arkansas River watershed. Therefore, the atrazine impairment associated with Arkansas River from Wichita to Derby is being incidentally addressed under this 4B alternative.

4. Projection of Time to Achieve Water Quality Standard: The first attempt to delist waters within the watershed that are listed for atrazine will be with the submission of the 2012-303(d) based on data collected by KDHE, USGS and KSU over 2006-2011.

5. Schedule for Implementing Controls: Pollution reduction practices should continue to be installed along the tributaries and the Little Arkansas River within the watershed over 2006-2011 using the WRAPS goal of increasing the amount of cropped acres having BMPs by 10% each year. Comprehensive long term watershed management and protection should proceed under the Kansas WRAPS process.

6. Milestones for 2011: The year 2011 reflects five years of implementation throughout the watershed and marks the next time KDHE will develop TMDLs in the Lower Arkansas River Basin. At this time, KDHE will assess this watershed and compile information regarding the targeted activities and participation in the implementation programs provided by the WRAPS group or other state funds within this watershed to evaluate whether the implementation of BMPs are being increased by 10% per year. The water quality endpoint goals described in this 4B alternative will be assessed and atrazine detections should achieve lower annual averages and fewer excursions of atrazine over 3ppb, and ideally averages will not exceed an average of 3 ppb at sampling stations within the watershed during the runoff period. At this time load reductions and atrazine detections will be assessed to evaluate the success of this 4B alternative. In addition, efforts may need to be refocused on particular streams within the watershed at this time.

7. Monitoring Plan

a. Ongoing sampling by KDHE on the Little Arkansas River and tributaries
b. Ongoing streamflow monitoring and occasional water quality sampling by USGS on the Little Arkansas River
c. Directed monitoring by KSU on Little Arkansas River, tributaries and demonstration projects
d. Watershed Specialist from KSU will document and track participation of BMP programs
e. Soil Conservation Commission will document and track cost-share Practices
f. WRAPS update meetings and reports will document the progress of achieving their goals

8. Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. Initial funding approved in 2003 totaling $144,670, provided through an $85,140 EPA Section 319 Grant and an additional $59,530 in local watershed matching funds, has been approved for the WRAPS process within this watershed. Further incremental Grant funding has recently been approved provided through Section 319 in the amount of

$101,869, along with $68,173 in local watershed matching funds for this watershed. Further consideration for future funding are contingent upon whether the watershed strategy is making progress towards meeting the water quality goals as defined in this document as well as the WRAPS.

9. Effectiveness: The BMPs identified by KSU are effective in alleviating atrazine loads as seen in the Perry Lake watershed. The State is committed to revise the strategy for the Little Arkansas River watershed if progress is not documented. If participation lags or there is no tangible decrease in the average atrazine levels seen along the Little Arkansas River, KDHE will initiate development of a TMDL in 2011. If the watershed strategy is proving to make progress towards meeting the water quality goals in 2011-2012, but cannot yet bring about delisting in 2012, KDHE will defer the decision to develop a TMDL until 2016. By this time the WRAPS goals should be complete and the restoration of the water quality should be evident. At that time, the 4B Alternative will be deemed a success, or KDHE will initiate a TMDL.

Revised 12/21/06

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Appendix A – Watershed Restoration and Protection Strategy For the Little Arkansas River Watershed.

http://www.kdheks.gov/nps/wraps/LittleArk_Final_wraps.pdf